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Investigating the Longevity of Survival Based Processing in Relation to True and False Memories

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Abstract

Previous research has demonstrated that survival processing enhances memory for target words, more so than other well known deep processing conditions. Survival processing has also been reported to increase false memories, yet, this was only examined using short retention delay conditions. The present study aimed to examine the longevity of survival processing in terms of true and false memory. A sample of 60 participants was recruited using an opportunity and snowball sampling method. The encoding task involved the processing of categorised nouns (category repetition procedure), by rating their relevance to either a survival or moving scenario, or by rating their pleasantness. After a delay of either five minutes or twenty-four hours, a surprise recognition test of the encoded words was given. The number of ‘yes’ responses to studied items (true memory), associated critical items and nonassociated items (false memory) were measured. Contrary to the hypothesis, the results revealed that survival processing, after a twenty-four-hour delay, led to a reduction in true memory. Potential reasons for this unexpected result are discussed with an emphasis on the use of the category repetition procedure. The twenty-four-hour delay also lead to an increase in false memory. This calls for additional research on survival based false memories after an extended delay between encoding and retrieval, in order to conclude whether false memory functions as an adaptive memory strategy.

Keywords:	False Memory	Longevity	Survival Processing	Category Repetition

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Cognitive Adaptations

Evolutionary psychologists (Tooby & Cosmides, 2005; Klein et al., 2002) highlight the importance of our ancestral environments and assert that natural selection results in cognitive adaptations. Cognitive adaptations, such as memory, helped to solve problems (E.g., finding food) in our ancestral past (Nairne et al., 2007). From an evolutionary standpoint, memory is believed to have selectively evolved for the purpose of survival and increasing reproductive fitness (Nairne et al., 2007; Nairne & Pandeirada, 2008). It has been argued that memory has evolved to be content sensitive rather than domain-general, as the retention of some information (E.g., the location of a predator) is more important due to its fitness relevance (Nairne & Pandeirada, 2008). Thus, researchers anticipated that survival-relevant information will produce a mnemonic advantage (Nairne et al., 2007; Butler et al., 2009). That is, when information in processed for its survival relevance, memorability for that information should increase.

Survival Processing

To test whether mnemonic advantage does, in fact, exist when processing words for their survival relevance, Nairne et al. (2007) employed a functional approach and developed the survival processing paradigm. The standard survival processing paradigm consists of an incidental learning task, in which subjects are asked to rate a list of randomly selected words for their relevance to a survival scenario. This scenario involves participants imagining themselves being stranded in grasslands of a foreign place. They do not have any necessary survival items, and their aim is to find food and protection from predators. After the rating task and a short (approximately five minutes) delay, subjects are given a surprise retention test of the rated words. Results revealed that more words were remembered when processed in terms of survival, compared to matched encoding scenarios, such as moving home or vacationing (E.g., Nairne et al., 2007; Kang et al., 2008; Nairne et al., 2008). Their findings lead to the conclusion that processing words for their survival relevance does, in fact, result in a mnemonic advantage.

As a result of numerous replications and extensions of the survival processing paradigm, the validity and robustness of the survival mnemonic phenomena strengthened. Various procedures and variable manipulations were employed. Researchers produced the survival mnemonic advantage using: within and between-subject designs (Nairne et al., 2007); varied age groups (Aslan & Bauml, 2012; Nairne et al., 2007; Pandeirada et al., 2014); and free recall as well as recognition tests (Kang et al., 2008; Nairne et al., 2008, 2007). Most importantly, memory levels, following survival processing, were higher when compared to various ‘deep processing’ conditions (Craik & Lockhart, 1972). These include intentional learning, pleasantness ratings and imagery (e.g., Nairne et al., 2008; Otgaar et al., 2011). Consequently, survival processing was concluded to be the best incidental encoding technique currently known in memory research (Nairne, 2010).

Nonetheless, all of the aforementioned studies used short retention intervals between learning and retrieval. Clark and Bruno (2015) argued the importance of remembering survival based information for prolonged period of time in order for it to aid future survival situations. Hence, the above-mentioned studies lack a focus on the longevity of survival processing advantage. The next section will discuss research which aimed to fill this gap in the literature.

Longevity of Survival Processing

Raymeakers et al. (2014) tested the longevity of survival processing advantage, to ascertain whether it truly holds adaptive value. To research this, they replicated the original survival processing paradigm, but instead of using only short retention intervals, they used delay periods of 24 and 48-hours. Results showed that, regardless of the time of testing, the survival condition produced higher retention scores, relative to a moving condition. This was the case for tests of free recall and recognition. Abel and Bäuml (2013) investigated recognition and recall levels between survival processing and a pleasantness task and, too, did not fail to find survival mnemonic advantage to last after 48 hours. Additionally, Clark and Bruno (2015), using a within-participants design, reported survival processing to enhance free recall, location based, memory after a 96-hour retention delay. A four-day retention delay was used because four to five days after encoding is where most of the forgetting supposedly occurs (Ebbinghaus, 1964). Since survival processing mnemonic advantage has the ability to last through extended retention delays, it was concluded that aspects of our memory system serve an adaptive function in remembering important events for the purpose of long-term planning (Raymeakers et al., 2014).

However, it is worth noting that, although the above-mentioned researchers have found the survival processing advantage in the different retention delay conditions, there was a general memory reduction with the increase of retention delay time (Clark & Bruno, 2015; Raymeakers et al., 2014). On the basis of the above findings, the current research aimed to investigate the effects of survival processing and delay on memory. Levels of true memories following survival processing (and control processing conditions) were compared between a twenty-four-hour and a five-minute retention delay. Although a general reduction of retention levels in the twenty-four-hour condition was expected, an overall improvement in memory following survival processing, relative to control conditions, was anticipated. In addition to the study of true memory, false memory was a key focus of this experiment. This is because research has shown survival processing to not only effect true memory but also false memory. The following section will give an overview of false memory in relation to survival processing.

False Memory

False memory has been defined as a subjective recollection of past occurrences which did not occur (Arndt, 2012). They have been proposed to occur as a result of the reconstructive nature of memory (Gallo & Lampinen, 2015). Existing research in the field of survival processing has primarily focused on true memory. Nonetheless, some researchers did investigate the prevalence of false memory (alongside true memory) as a consequence of survival processing. Since survival processing is an adaptive memory strategy, it should not only increase true memory but simultaneously decrease the susceptibility to false memory (Otgaar & Smeets, 2010). However, the general finding revealed that survival processing increased not only true memories but also false memories of non-presented words (Nairne et al., 2007, Experiment 1; Howe & Derbish, 2010; Otgaar & Smeets, 2010; Howe, 2011).

In Otgaar and Smeets' (2010) study, for example, when the net accuracy score with total output was calculated from all three of their experiments, no overall survival recall advantage was apparent. Therefore, these findings question the adaptive memory strategy of survival processing (Otgaar & Smeets, 2010).

On the other hand, alternative research indicates that false memory from survival processing can function as an adaptive memory strategy. According to Howe and Derbish (2010), false memories arising from survival processing can be a by-product of the fitness-relevant mechanism. Activation of semantically related information can function as a guidance to other survival-relevant information resulting in enhanced survivability. Alternatively, false memory itself may serve an adaptive function (Howe, 2011). For example, as noted by Howe and Derbish (2010), falsely remembering the presence of a predator in a location which only had signs of a predator can be advantageous for one's survival. Therefore, false memory from survival processing can lead to adaptive consequences. Problem-solving is one of the adaptive consequences that false memories from survival processing can enhance. Gardner and Howe (2014) investigated the survival advantage of false memory using a compound remote associative task, which was primed by false memories. They found that the survival condition led to more false memories and improved subsequent task solving, more so than a moving condition. This indicates that false memories, from survival processing, facilitate problem-solving more so than false memories from other processing conditions, such as a moving condition. This is further validated by other research (E.g., Howe, 2011; Howe et al., 2011; Howe et al., 2013), which further supports the adaptive function of false memories from survival processing.

However, no research has yet investigated the effects of survival processing on false memories after an extended retention delay. Therefore, it is unknown whether survival processing would increase the vulnerability to false memories after, for example, twenty-four hours between encoding and retrieval. Investigation of this was the central focus of this experiment. Using a twenty-four-hour delay, the researcher investigated the effects of retention delay on false memory, following various processing scenarios. False memory was induced in each processing condition by the use of the category repetition procedure. This procedure is introduced in the next section, alongside explanations for the occurrence of false memory when the category repetition procedure is used.

Inducing False Memory
Various paradigms can be used to induce and study false memory. Of these, the DRM and category repetition procedures are the most widely used. The DRM paradigm (Deese, 1959; Roediger & McDermott, 1995) was employed in Otgaar and Smeets' (2010) experiments 1 and 2. It is specifically constructed to prompt false memories; thus, as pointed out by Otgaar and Smeets (2010), it can be argued to bias the survival recall results. For this reason, Otgaar and Smeets used the category repetition procedure (Dewhurst & Anderson, 1999) in Experiment 3, as it was not specifically created to trigger false memory. Although levels of false memory dropped, they nonetheless found false memory levels to be higher for survival processing, relative to other processing conditions. Hence, the current experiment also used the category repetition procedure. More specifically, categories from Overschelde's et al. (2004) category norms were selected. Overschelde et al. (2004)

adapted the norms of Battig and Montague (1969), by adding 14 new categories, as they believed that people's knowledge of category membership was not accurately reflected by the norms of Battig and Montague.

The category repetition procedure involves participants learning a list of words from taxonomic semantic categories. During recognition tests, non-studied words (critical exemplar lures) from a target category are frequently falsely recognised (Dewhurst, 2001; Dewhurst & Farrand, 2004). For example, following the study of a list of fruits such as mango, strawberry, orange etc. the subject is likely to falsely recognise the non-presented exemplar, apple. Dewhurst and Anderson (1999) varied the number of words presented to participants and found that with the increase of presented words, critical lures were more often falsely recognised. They also investigated the strength of false memories by exploring participant's subjective states of awareness for recognised words. To do this, they employed the remember-know procedure (Tulving, 1985), which will be discussed later. They found that with the increase of words from the same category, more 'remember' and 'know' responses accompanied the non-presented words. This means that the responses were not merely guesses but were false memories. One possible explanation for the occurrence of false memory is presented below.

The activation-monitoring account helps to understand why false recall and recognition occurs in paradigms such as the category repetition procedure (Dewhurst, 2001). The monitoring component suggests that memory errors occur due to source monitoring failure. The activation component suggests a spontaneous generation of associates of presented words (Underwood, 1965). Dewhurst et al. (2005), using the remember-know procedure, found that when a secondary task is performed to interfere with the generation of associates, the number of false 'remember' responses decreased. Whereas, the encouragement of associates generation increased false 'remember' responses. Their findings support the view that activation of semantic associates produces false memories of non-studied words from a category. Measuring the subjective experiences of recognised words is important to understand how strong that recognition level is. For this reason, this experiment utilised the remember-know procedure, which is described below.

Remember-Know Procedure

The remember-know procedure, introduced by Tulving (1985), helps to understand states of awareness that come with retrieval. It assumes that judgments in recognition memory are based on two distinct memory systems: remembering and knowing. Tulving described remembering as a conscious recollection and a reflection of episodic memory (memory for personal events). Knowing, on the other hand, was described as a reflection of semantic memory (impersonal, factual knowledge). However, knowing judgements can be attributed to episodic events, thus, other researchers describe knowing as a feeling of familiarity (Madler, 1980). A 'guess' response is often incorporated into experiments. Gardiner et al. (1998) assert that the guess response also reflects feelings of familiarity, but it is different to knowing by its use of numerous inferences which are not directly linked to memory. According to Miller and Wolford (1999), subjects may state that they recognise a word from a list because they have a response bias toward it, as it relates to the studied list. So, responses may simply be guesses with no actual false memory. Therefore, it is essential to measure the subjective experiences that accompany participant's responses to identify false memories. The current experiment utilised the 'remember-know' procedure, as a way of examining subjective experiences of true and false memories of recognised words.

Current Study
On the basis of the above research, the current study employed the category repetition procedure (Dewhurst & Anderson, 1999), by drawing categories from Overschelde's et al. (2004) category norms to induce false recognition. The remember-know procedure (Tulving, 1985) was used to examine participant's subjective experiences of recognition. True and false recognition was examined in relation three different processing conditions (survival, moving, pleasantness) and two retention delay conditions (24-hours, 5-minutes). The principal aim was to investigate whether survival processing yields different levels of true and false memories in immediate and delayed retention tests, relative to control processing conditions. In line with previous findings, it was hypothesised that, on both immediate tests and following a twenty-four-hour delay, survival processing will produce higher levels of true memory relative to other processing conditions. An overall decrease in true memories with the one-day delay was expected, as this was the general finding with past research. In addition, the current experiment aimed to assess if the memory advantage for the survival condition remained constant over a delay period. Since previous research indicates that survival processing, relative to other processing conditions, yields higher levels of associative false memory after a short delay, this was expected in the current research. In addition, the current research tested whether this effect persisted after a twenty-four-hour delay. A confirmation of this hypothesis will indicate that false memory is adaptive and functions in a survival-enhancing manner.

Methodology

Participants
Sixty participants (43 females, 17 males), living in Manchester, took part in this experiment. The age of the participants ranged from 18 to 35. The sample was obtained via an opportunity and a snowball sampling methods. The aim was to gather a sample size close to the sample (N=81) used by Raymeakers et al. (2014). All of the participants were 18 years old or over so they could provide their own consent to take part in the experiment.

Design
An experimental design, consisting of two Independent Variables (IV) and four Dependent Variables (DV), was used in this experiment. The first IV was the encoding task. It was manipulated between subjects with individuals randomly allocated to one of three levels; survival vs. moving vs. pleasantness (ten participants per condition). The second IV was the length of delay between encoding and memory test. It was manipulated between subjects with individuals randomly allocated to either a 5-minute delay test condition or a 24-hour delay test condition (30 participants per condition). A between-subject design was important in this experiment to effectively compare recognition performance between the processing and the retention conditions.

Four dependent variables were used in this experiment. 'Yes' responses indicate recognition in the retention test. The first DV was the 'yes' response to studied words. DV two was the ‘yes’ response to critical lures from studied lists. The third DV was ‘yes’ response to the non-studied words from the non-studied list. The fourth DV was ‘yes’ response to critical lures from the non-studied list. Each of these four main dependent variables were further sub-divided into ‘recognise’, ‘know’ or ‘guess’, to help to determine false recollections.

Apparatus & Materials

A category repetition procedure (Dewhurst & Anderson, 1999) was used to present subjects with a standard categorised list. A total of 14 categories were selected from Overschelde’s et al. (2004) category norms. The use of standardised categories in an experimental setting allowed for the manipulation of false memory production across all processing conditions. The selection criteria for this experiment included categories that possess the labels of one word (including hyphened words), that were nouns, and that were familiar to the participants. Within each of the 14 gathered lists, the top 11 ranked items were selected, the first of these were the most dominant exemplar of the category (critical lure), which were not presented at learning. For example, for the category *‘fruits’*, the most dominant exemplar is ‘*apple’,* which was only presented in the recognition test. The 14 categories were divided randomly into two 7’s for the purpose of counterbalancing. Only 7 of these were presented during learning. The other 7 categories were incorporated with the learnt list for the recognition test. The words from both groups (learnt and non-learnt) were presented on two different PowerPoint slides with one word per page. Each word was presented in bold, Arial Black font, and size 60.

Additionally, the remember-know procedure (Gardiner, 1988; Tulving, 1985) was used in the recognition part of the experiment. After the participants responded with a ‘yes’ (recognition) for the words presented in the recognition test, they were required to state how strong the recognition memory was for each word by saying ‘remember’ (conscious recollection), ‘know’ (feeling of familiarity) or ‘guess’. This procedure helped to determine whether false recognition responses were actually false memories.

Procedure

Subjects entered the experimental room believing that the experiment is based on cognitive ability and the processing of words. It was vital that the participants were unaware that the experiment was measuring memory for incidental learning to be possible. Before the experiment commenced, participants were asked to provide a written consent. Each subject was assigned to one of the three processing conditions. The conditions, pleasantness, survival and moving were used, worded in a similar way to those used in the experiments of Nairne et al. (2007). In the pleasantness condition, subject rated words for their pleasantness. In the survival condition, subjects rated words for their relevance to a survival situation. In the moving scenario, subjects rated words for their relevance to moving a house. In each condition, a list of 70 words (10 words per category) was presented in categorical order. Each word was timed to show for 5 seconds each, followed by a blank screen to give time to respond. The participants were asked to rate each word on a 5-point scale, with 1 being extremely unpleasant/ extremely irrelevant, to 5 being extremely pleasant/ extremely relevant. To eliminate the potential confound of processing time, participants were asked to rate each word within 5 seconds after the word was presented. This task was the incidental learning phase. Following the completion of the task, subjects in the short interval condition engaged in a 2-minute nonverbal distractor task (Tetris), while subjects in the delayed condition went home and were asked to return the next day for additional testing.

Following the 2-minute or 24-hour delay, participants were given instructions for the surprise recognition test. Note that in the short interval conditions, the 2-minute Tetris game and the time used to give instructions for the recognition test were added to give an approximate overall 5-miute delay between encoding and retrieval. The recognition test involved the presentation of studied and non-studied words from each category (ranked 4 and 7) as well as studied and non-studied critical lures (ranked 1) from each category. A total of 42 words were presented during the recognition test. The participants verbally stated whether they recognise each word from the previous list of words. For each 'yes' response, the participants further stated whether their responses were accompanied by recollective experience, knowing or simply a guess. Upon completion of the experiment, all subjects were fully debriefed and informed of the true aims of the study. They provided an anonymous personal code by which their results could be identified by if they subsequently wished to withdraw their results from the study. All of the data was secured by a password-protected computer, and the raw data was deleted upon analysis completion.

Results

Overview of Results

The number of yes responses to each type of item (studied, critical lure and unrelated) were entered into sets of univariate ANOVAs. These comprised a series of 3 (Encoding task; survival vs. moving vs. pleasant) between-subjects by 2 (Delay; 5 mins vs. 1 day) between-subjects ANOVAs. These were further subdivided into remember, know and guess responses. Results for different response types are presented in separate sections below.

True Memory

The descriptive statistics can be found in Table 1. The analysis on overall true memory revealed a non-significant main effect of encoding task, $F(2, 54) = 1.22$, $p = .30$. The main effect of delay was marginally significant, $F(1, 54) = 3.11$, $p = .08$, with slightly more overall true memories in the five-minute delay. The interaction was significant, $F(2, 54) = 4.81$, $p = .01$. This interaction was assessed further by the use of simple main effects comparing delay at each level of the encoding task. This was done by the use of independent t-tests, which revealed a significant difference between the five-minute and the one-day condition for survival processed words, $t(9.22) = 2.51$, $p = .03$ (Levine's adjusted), showing fewer true memories after a one-day delay. The effect of delay had no influence in the pleasant or moving conditions, $t(18) = 0.47$, $p = .79$ and, $t(18) = 0.72$, $p = .48$ respectively. Additional comparisons were made between the survival condition and the other encoding conditions at each level of delay. This demonstrated no significant differences across any comparison apart from that between survival and moving at the one-day delay $t(18) = 2.14$, $p = .05$. All other comparisons demonstrated p's > .05.

The analysis on remember responses revealed a non-significant main effect of encoding task, $F(2, 54) = 1.03$, $p = .0.37$. The main effect of delay was not significant, $F(1, 54) = 2.01$, $p = .16$. The interaction was marginally significant, $F(2, 54) = 2.95$, $p = .06$. Inspection of the means for the remember responses showed a similar pattern of results to overall responses with the largest numerical difference between the five-minute and one-day delay for the survival condition. There were less remember responses after a one-day delay.

The analysis on know responses revealed a non-significant main effect of encoding task, $F(2, 54) = 0.32$, $p = .73$. The main effect of delay was not significant, $F(1, 54) = 0.03$, $p = .87$. The interaction was not significant, $F(2, 54) = 0.54$, $p = .59$.

The analysis on guess responses revealed a non-significant main effect of encoding task, $F(2, 54) = 0.83$, $p = .44$. The main effect of delay was marginally significant, $F(1, 54) = 3.08$ $p = .08$. There were slightly more guess responses after a one-day delay. The interaction was not significant, $F(2, 54) = 1.14$, $p = .33$.

Table 1
Mean and standard deviation of true memory for encoding tasks, delay, and remember, know, guess responses.

		Encoding Condition					
		Survival		**Moving**		**Pleasantness**	
		M	*SD*	*M*	*SD*	*M*	*SD*
Delay							
5 min	Overall	13.90	0.32	13.20	1.62	13.40	0.97
1 day		11.60	2.88	13.60	0.70	13.30	0.67
5 min	Remember	11.50	2.99	10.80	4.32	10.60	2.46
1 day		7.80	3.49	10.50	2.01	11.30	2.06
5 min	Know	2.10	2.88	2.20	3.01	2.30	2.31
1 day		2.80	2.30	2.60	2.12	1.50	1.65
5 min	Guess	0.30	0.67	0.20	0.42	0.50	0.53
1 day		1.00	1.05	0.50	0.97	0.50	0.53

False Memory for Critical Items
The descriptive statistics can be found in Table 2. The analysis on associative false memory revealed a non-significant main effect of encoding task, $F(2, 54) = 1.54$, $p =$

.22. The main effect of delay was significant, $F(1, 54) = 11.21$, $p = .001$, showing more overall associative false memories after one day. The interaction was not significant, $F(2, 54) = .06$, $p = .94$.

The analysis on remember responses revealed a non-significant main effect of encoding task, $F(2, 54) = .45$, $p = .64$. The main effect of delay was not significant, $F(1, 54) = .6$, $p = .44$. The interaction was not significant, $F(2, 54) = .17$, $p = .85$.

The analysis on know responses revealed a non-significant main effect of encoding task, $F(2, 54) = 1.54$, $p = .22$. The main effect of delay was significant, $F(1, 54) = 9.13$, $p = .004$, showing more know responses after one day. The interaction was not significant, $F(2, 54) = .33$, $p = .72$.

The analysis on guess responses revealed a non-significant main effect of encoding task, $F(2, 54) = .06$, $p = .0.94$. The main effect of delay was not significant, $F(1, 54) = 1.60$, $p = .21$. The interaction was not significant, $F(2, 54) = .6$, $p = .55$.

Table 2
Mean and standard deviation of associative false memory for encoding tasks, delay, and remember, know, guess responses.

		Encoding Condition					
		Survival		**Moving**		**Pleasantness**	
		M	*SD*	*M*	*SD*	*M*	*SD*
Delay							
5 min	Overall	3.50	2.37	3.70	1.42	2.90	2.08
1 day	Overall	5.10	1.73	5.50	1.58	4.30	1.77
5 min	Remember	1.40	1.84	1.90	1.10	1.10	1.91
1 day	Remember	1.80	1.81	1.90	1.60	1.70	1.64
5 min	Know	1.00	0.94	0.90	1.10	0.40	0.52
1 day	Know	1.50	1.27	1.90	1.20	1.30	0.95
5 min	Guess	1.10	1.20	0.90	1.37	1.40	1.35
1 day	Guess	1.80	1.40	1.70	2.00	1.30	1.06

False Memory for Unrelated Items
These were computed by averaging together the yes responses to the critical lures from non-presented lists with the non-presented words from non-presented lists. The descriptive statistics can be found in Table 3. The analysis on unassociated false memory revealed a non-significant main effect of encoding task, $F(2, 54) = .69$, $p = .51$. The main effect of delay was significant, $F(1, 54) = 6.83$, $p = .01$, showing more unassociated false memories after one day. The interaction was not significant, $F(2, 54) = 1.36$, $p = .27$.

The analysis on remember responses revealed a non-significant main effect of encoding task, $F(2, 54) = .17$, $p = .85$. The main effect of delay was not significant, $F(1, 54) = 1.05$, $p = .31$. The interaction was not significant, $F(2, 54) = 1.17$, $p = .32$.

The analysis on know responses revealed a non-significant main effect of encoding task, $F(2, 54) = .48$, $p = .62$. The main effect of delay was significant, $F(1, 54) = 6.77$, $p = .01$, which revealed more know responses after one day. The interaction was not significant, $F(2, 54) = .00$, $p = 1.00$.

The analysis on guess responses revealed a significant main effect of encoding task, $F(2, 54) = 3.14$, $p = .05$. The highest number of guess responses were in the pleasantness condition. The main effect of delay was marginally significant, $F(1, 54) = 3.68$, $p = .06$, which revealed slightly more guess responses after one day. The interaction was not significant, $F(2, 54) = 1.76$, $p = .18$.

Table 3
Mean and standard deviation of unassociated false memory for encoding tasks, delay, and remember, know, guess responses.

		Encoding Condition					
		Survival		**Moving**		**Pleasantness**	
		M	*SD*	*M*	*SD*	*M*	*SD*
Delay							
5 min	Overall	0.30	0.54	0.10	0.21	0.40	0.81
1 day		0.45	0.76	1.15	1.42	0.95	0.56
5 min	Remember	0.10	0.32	0.00	0.00	0.05	0.16
1 day		0.05	0.16	0.25	0.63	0.10	0.21
5 min	Know	0.10	0.21	0.10	0.21	0.00	0.00
1 day		0.35	0.63	0.35	0.41	0.25	0.42

5 min	Guess	0.10	0.21	0.00	0.00	0.35	0.78
1 day		0.05	0.16	0.55	0.69	0.60	0.61

Summary of True Memory Results
The analysis revealed that survival processing did not produce any memory advantage on the immediate test of memory. Thus, the survival processing effect was not replicated. A difference only emerged after a 24-hour delay and was opposite to that hypothesised; there was a reduction in true memory and remember responses and a slight increase in guess responses, which indicates low confidence levels of recognition. Essentially, this experiment did not find a survival processing advantage for categorised word lists after a twenty-four- hour delay.

Summary of False Memory for Critical Items Results
The analysis revealed that associative false memory was greater after a delay and this was largely reflected in the know responses. There was no interaction between encoding task and delay for associative false memory and for different response types.

Summary of False Memory for Unrelated Items Results
The results revealed that overall unassociated false memory was greater after one day. This was mainly reflected by know responses, and guess responses to a lesser extent. The interaction between encoding task and delay for unassociated false memory was not significant overall and for different response types.

Discussion

This study aimed to investigate the levels of true and false memories following survival processing after five minutes and a one-day retention delay. Note that the results for true and false memory are discussed separately.

Although a general decrease in true memory after a twenty-four-hour delay was expected, it was hypothesised that true memory would be higher after survival processing relative to other processing conditions. A confirmation of this prediction would have further validated past research on the longevity of survival processing. Hence, it would have confirmed the adaptive function of memory in serving long-term survival goals (Raymeakers et al., 2014).

However, contrary to the predictions, the results have shown that following survival processing, true memories declined after a one-day delay. In line with past research (Raymeakers et al., 2014; Clark & Bruno, 2015), a general decline in true memories after one day was expected, partly due to the traditional understanding that memory deteriorates after prolonged retention intervals (Ebbinghausian, 1964). Nonetheless, true memories after a one-day delay were expected to be higher for survival processing than for other processing conditions. This was not reflected in the results because a one-day delay affected (decreased) true memories for only survival processing and not other processing conditions. Essentially, true memory levels were the lowest for survival condition after one day. These results stand in contrast to previous research findings of survival processing leading to a mnemonic advantage after an extended retention delay (including 24 hours) (Abel & Bäuml, 2013; Raymeakers et al., 2014; Clark & Bruno, 2015).

There is no clear answer as to why the survival processing advantage was not found in this study. For this reason, three possible explanations will be considered. Perchance, the hypothesis was not confirmed due to the use of the category repetition procedure. It is possible that the use of categorised words led subjects to process words in an interrelated manner across all encoding tasks and therefore influenced memory equally. However, this cannot represent the whole of the answer because a difference did emerge after a one-day delay. Alternatively, perhaps the survival processing advantage was not found because the sample size was relatively small. Only ten participants per encoding and delay condition potentially were not enough to achieve the survival processing effect. A sample closer to the number of participants (81) used in the study by Raymeakers et al. (2014), may have helped to produce the survival processing advantage.

A final consideration is that of congruity. Congruity effect is referred to as superior retention of items when they match with the type of processing (Nairne et al., 2007). For example, when processing survival type words for their survival relevance, the retention of those words improves. This is because the memory system is tuned to remember material that is relevant to the goal of processing (Butler et al., 2009). Butler et al. (2009) in experiments 2 and 3, found that when types of words and the processing task are congruent, recall performance was highest. Therefore, perhaps the current study did not find survival advantage because of the incongruency effect. If the current study used items which were congruent with the processing task, survival processing advantage may have occurred. This is not always the case, though, as congruency between items and task does not always lead to survival recall advantage, as shown in Butler's et al. (2009) experiments 2 and 3. This indicates that congruence is not necessary to produce the survival processing effect. Nevertheless, their use of mixed list of high and low relevance words may be the reason for this result. Therefore, more research is required to understand the boundary conditions under which the survival processing advantage occurs. Consequently, the incongruency effect in the categorised words can only partly explain the reason for not finding the survival processing advantage in the current experiment. Although a definite answer is unknown, all three points discussed could have contributed to the results obtained. For this reason, future research should focus on obtaining a larger sample than the one used in this study. Extra precaution should also be taken with the material, especially if categorised words are used. Using categorised words that are congruent with the processing task may be advantageous in aiding survival processing effect to occur.

In terms of false memory, the results revealed an overall higher level of associated and unassociated false memories after a one-day delay relative to five-minute delay. This was mainly reflected in the know responses, which indicates feelings of familiarity. The fact that there was no interaction between delay and encoding tasks shows that all encoding conditions, rather than isolated survival condition, led to increased false memory. Yet, it was hypothesised that survival condition, as opposed to other processing conditions, after a one-day delay would lead to an increase in false memories. So, although a general increase in false memories was found, this was not reflected in just survival processing condition, as hypothesised.

Previous work (Nairne et al., 2007, Experiment 1; Howe & Derbish, 2010; Otgaar & Smeets, 2010; Howe, 2011) reported that, after a short retention delay, survival processing leads to more false memories than control scenarios. Using these findings, researchers have speculated and assessed whether increased survival based false memory functions as an adaptive memory strategy, or if in fact, it does the opposite. The majority of research draws on the idea that survival based false memories can lead to adaptive consequences such as enhanced survivability and improved problem-solving skills (E.g., Howe & Derbish, 2010; Howe, 2011; Gardner & Howe, 2014). However, the research that these speculations draw from involved only short retention delay periods. Yet, Clark and Bruno (2015) argued that, for survival advantage to be an adaptive memory strategy, it must last over an extended period of time. Although Clark and Bruno were referring to true memories, the same should apply for false memories. Since survival based false memories are said to be an adaptive memory strategy, then expectantly, over an extended retention delay, they should remain higher than false memories from other conditions. Only this way the information can be used for future survival situations. However, the current research, after a twenty-four-hour delay, did not find survival processing to increase false memories any more than the other conditions. Thus, arguably, survival based false memory cannot be an adaptive memory strategy, as claimed by researchers such as Howe (2011), because it is no bigger than false memories from other processing conditions.

This research was the first to investigate the effects of survival processing on false memories, after prolonged retention delay. Thus, research is yet to investigate the advantage of survival based false memory, after an extended delay, on processes such as problem-solving. This shift of focus on the longevity of survival based false memory will help to verify whether activation of survival-relevant associates can be an adaptive function of memory for enhancing survivability. But, with the current findings, it appears that false memory from survival processing cannot be said to be an adaptive memory strategy because the observed increase in false memories was the product of not only survival processing.

Overall, the results revealed that the survival processing advantage, in terms of true memory, can be absent in research under certain circumstances. The use of the category repetition procedure appears to have been a limitation in this research due to potentially preventing survival processing effect. For this reason, future research is advised to use categories which are congruent with the processing task. This study was the first to investigate survival based associative false memories after a delay of 24 hours. Since false memories did not increase specifically due to survival processing, the current findings question whether survival based false memories are truly an adaptive memory strategy. These findings call for more research on survival based false memories after a delay of 24 hours or longer. Only this way, conclusions regarding the advantages of survival based false memory can be made. It is worth noting that, since the sample used in this study was not large enough and consisted on mostly female participant (43 out of 60), future studies should gather a larger and more representative sample of both sexes. Nonetheless, overall, this study has contributed to the understanding of associative false memories following survival processing. It has also revealed that the items studied can influence whether a survival processing advantage appears, which informs future research to take extra precaution with study materials.

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